

HYDROLOGY REPORT

Preliminary Drainage Basin Characteristics for Irving Bridge #2405 in Old Town on Route 16 over Pushaw Stream was developed by the Maine Department of Transportation Office of the Environment-Hydrology Section. Design Q_{50} flow was calculated to be 5,500 cfs.

The Soil Conservation Service conducted a flood frequency study of the Pushaw Stream in 1976 and established a Q_{50} design flow of 7,500 cfs at the confluence of the Pushaw Stream and the Stillwater River, approx. $\frac{1}{4}$ mile downstream.

In 1972 Arvah Lyon of the MaineDOT Bridge Design Section performed a hydrology study for the Lancaster Bridge over the Pushaw Stream, approximately 0.5 miles upstream. He calculated the Q_{50} design flow to be 5,670 cfs.

Charles Hebson of MaineDOT environmental office indicated that the difference between the 7,500 cfs reported by Soil Conservation and the 5,500 cfs reported by his preliminary calculations are statistically insignificant and therefore the Soil Conservation flows should be used for design.

The hydrology data is as follows:

Summary

Drainage Area	=	230 square miles
Ordinary High Water ($Q_{1.1}$)	=	2,400 cfs
10 Year Flood (Q_{10})	=	5,200 cfs
Design Discharge (Q_{50})	=	7,500 cfs
Check Discharge (Q_{100})	=	8,800 cfs
Superflood Q_{500}	=	12,300 cfs
Flood of Record (May 1, 1923 on the Penobscot)		
Milford Pond El. 107.4		
Gilman Falls pond within 0.10' according to PPL.		

Reported By: Edward Caswell
Date: August 30, 2004

HYDRAULIC REPORT

The existing bridge is an 81 foot span pony truss supported on deep abutments with straight return wings with a waterway opening of 5,200 sf. The following flow and tailwater data taken from the 1976 Soils Conservation Service Flood Frequency study was used in evaluating the hydraulics of the existing opening:

	<u>Design Flow</u>	<u>Tailwater El.</u>
Discharge @ $Q_{1.1}$	2,400 cfs	103.00 ft
Discharge @ Q_{10}	5,200 cfs	105.40 ft
Discharge @ Q_{50}	7,500 cfs	107.60 ft
Discharge @ Q_{100}	8,800 cfs	108.60 ft
Discharge @ Q_{500}	12,300 cfs	111.10 ft

The geometry of the existing opening, vertical deep abutments with 90 degree straight return wings, creates a severe flow condition with high velocities with the resulting scours exceeding 20 feet.

A bridge scour evaluation of the Irving Bridge was performed by T.Y. Lin International in 1995. They concluded that the risk of scour at this site is low for the following reasons:

1. Streambed cross-section aggraded 1.0 to 1.5 feet since 1937
2. Low potential velocity at the bridge.
3. No history of scour
4. No potential for overtopping or pressure flow. The Pushaw Stream watershed is relatively flat with significant swamp flood storage, potentially reducing peak flows at the bridge.

HEC-18 does not accurately predict local scour at abutments so the total scour depths calculated are exaggerated. This is born out by the following:

- The depth of the existing stone foundations is unknown but unlikely to extend more than 20 feet below streambed. If the local scour were as great as predicted, the existing abutments would likely have been destroyed years ago.
- Scour inspections indicate that there is no scour evident and the gravelly streambed appears stable.
- Scour problems have not been reported in MaineDOT maintenance reports or by the bridge maintenance supervisor.

Scour depth calculations may not be entirely accurate but they provide a tool for relative comparisons of alternative bridge openings.

EXISTING BRIDGE SUMMARY

	<u>Exist. Structure</u> 81 ' span
Total Area of Waterway Opening	5200 ft ²
Headwater Elevation @ Q _{1.1}	103.25 ft
Headwater Elevation @ Q ₁₀	105.94 ft
Headwater Elevation @ Q ₅₀	108.24 ft
Headwater Elevation @ Q ₁₀₀	109.30 ft
Headwater Elevation @ Q ₅₀₀	112.26 ft
Freeboard @ Q ₅₀	0.76 ft
Discharge Velocity @ Q _{1.1}	4.21 ft/s
Discharge Velocity @ Q ₁₀	7.10 ft/s
Discharge Velocity @ Q ₅₀	8.55 ft/s
Discharge Velocity @ Q ₁₀₀	9.36 ft/s
Discharge Velocity @ Q ₅₀₀	10.92 ft/s
Scour Depth, Abut #2 at Q100	23.00 ft

Three simple span options were reviewed, 120', 135' and 150' spans. Contraction and local scour were evaluated with HEC-RAS using the methods of HEC-18. The superflood scour event used for design was Q100 because it is the flow level when the roadway to the south of the bridge is overtopped. The three openings reviewed significantly reduced the abutment scour. The 120' span option reduced total scour by 35%, 135' span by 45% and 150' span by 52%. The existing opening and 120' option were also analyzed for scour at approximately the flow levels predicted by the MaineDOT Environment-Hydrology group in order to determine the sensitivity of the site to scour at varying stream flows. Scour depth for the existing bridge was reduced by two feet and the 120' span scour depth was reduced by one foot.

The relative change of scour depth of the 120' opening compared to the existing opening is dramatic. Increasing the opening to 135' and 150' makes only modest improvements in local scour.

All three options provide adequate openings to pass the design flows with significant improvements in scour potential. The 120' opening reduces outlet velocity at Q50 flows

from 8.55 fps to 6.33 fps, the total scour depth by 35%, and the headwater elevation is reduced from 108.24 to 107.99.

SUMMARY

	<u>Exist. Structure</u> 81 ' span	<u>Option 1</u> 120 ' span <u>Recommended</u>	<u>Option 2</u> 135 ' span	<u>Option 3</u> 150 ' span
Total Area of Waterway Opening	5200 ft ²	6800 ft ²	7916 ft ²	9035 ft ²
Headwater Elevation @ Q _{1.1}	103.25 ft	103.18 ft	103.16 ft	103.15 ft
Headwater Elevation @ Q ₁₀	105.94 ft	105.77 ft	105.71 ft	105.69 ft
Headwater Elevation @ Q ₅₀	108.24 ft	107.99 ft	107.90 ft	107.87 ft
Headwater Elevation @ Q ₁₀₀	109.30 ft	109.00 ft	108.89 ft	108.86 ft
Headwater Elevation @ Q ₅₀₀	112.26 ft	111.63 ft	111.44 ft	111.31 ft
Freeboard @ Q ₅₀	0.76 ft	1.01 ft	1.10 ft	1.13 ft
Discharge Velocity @ Q _{1.1}	4.21 ft/s	3.32 ft/s	2.78 ft/s	2.38 ft/s
Discharge Velocity @ Q ₁₀	7.10 ft/s	5.42 ft/s	4.55 ft/s	3.89 ft/s
Discharge Velocity @ Q ₅₀	8.55 ft/s	6.33 ft/s	5.34 ft/s	4.58 ft/s
Discharge Velocity @ Q ₁₀₀	9.36 ft/s	6.81 ft/s	5.77 ft/s	4.95 ft/s
Discharge Velocity @ Q ₅₀₀	10.92 ft/s	7.76 ft/s	6.68 ft/s	5.78 ft/s
Scour Depth, Abut #2 at Q100	23.00 ft	15.00 ft	13.00 ft	11.00 ft

Reported By: Edward Caswell
Date: August 30, 2004

Note: All elevations based on North American Vertical Datum (NAVD) of 1988.
Elevations based on the National Geodetic Vertical Datum (NGVD) of 1929 were converted to NAVD by subtracting 0.60'